From theory to practice—how insights from psychology can be applied in agricultural extension

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Abstract. It is generally recognised that knowledge of technical issues is not sufficient to drive adoption and that extension programs can benefit from considering psychological factors that shape behaviour. There are many factors that influence adoption, from individual psychological and demographic factors, farm-level, through to broader environmental and institutional context. This paper provides a selective overview of psychological factors that can influence adoption. We outline the theoretical basis for considering these factors, examples of how psychological factors have been applied within practice change programs, and recommendations for how to consider these factors in extension practice and design. We explore how to harness the power of norms and efficacy, situate practice change within daily needs, work with the values and culture of farmers and industry norms, maximise power of social networks, and by understanding the challenges of practice change, set realistic goals. Importantly, changing an agricultural practice requires changing a complex series of multiple actions over long periods of time. This complexity means that promoting adoption of many agricultural practices typically requires more support and longer time periods. Understanding where farmers are at and collaborations with industry groups support change over years, rather than months.

Keywords: psychology, behavioural science, extension, norms, efficacy, social capital, values, wellbeing

Introduction

Extension programs are diverse, encompassing a broad range of goals from promoting technology transfer and supporting farm management, through to promoting environmental sustainability and risk management (Norton & Alwang 2020). Broadening models of service delivery and better targeting needs of individual farmers across diverse landscapes can support better extension outcomes and adoption of new practices (Norton & Alwang 2020). One aspect of providing tailored extension services is understanding the psychological factors that shape how farmers and landholders engage with extension programs, and adoption of new practices.

There is increasing recognition that knowledge of technical issues is not sufficient to drive the adoption of new practices, and that programs supporting adoption need to consider psychological factors that shape behaviour (Kollmuss & Agyeman 2002; Pickering et al. 2020). Insights from behavioural science can be used to uncover and understand the psychological factors that can influence behaviour and then use those insights to guide the delivery of programs and projects that have a focus on changing a target audiences' behaviour.

For example, many agricultural extension program in Queensland, Australia, work with farmers to improve water quality in Great Barrier Reef catchments, and the most recent Reef 2050 Scientific Consensus Statement identified the application of behavioural sciences to changing farmers behaviour as a key knowledge gap (Commonwealth of Australia 2018; Eberhard et al. 2021). Since that time, research has gone some way to identify specific psychological factors that can influence agricultural management practice adoption (Delaroche 2020; Foguesatto et al. 2020; Streletskaya et al. 2020; Coggan et al. 2021; Tama et al. 2021).

Scope of the current review

We note that this review is not intended to represent a systematic overview of all factors that influence adoption or a new explanatory model of adoption. Rather, this review is intended to highlight a selective set of psychological factors that may influence extension success, and provide a deeper dive into describing these concepts and exploring how they can be considered within extension practice.

We draw on a larger expert elicitation project that explored the effectiveness of policy instruments such as extension or regulations (Mayfield et al. 2023). This project examined the influence of diverse practice and farmer characteristics on effectiveness of these instruments—including a range of psychological factors. While many of the psychological factors emerging within this project align with established research, given that the broader study we draw on is an expert elicitation study, this allows for little-studied concepts to be considered (Mayfield et al. 2023). Here we provide an exploration about how some of the psychological factors identified within this project could influence adoption, and examples of how these findings can be applied by extension officers.

We acknowledge that there are numerous other factors that shape landholder practices and models of adoption that are beyond the scope of this review. We recognise that contextual factors may be equally or more important influences on adoption, including environmental factors, socio-economic factors, broader social systems and policy settings (Anibaldi et al. 2021; Eberhard et al. 2021; Roemer et al. 2021; David et al. 2022; Mayfield et al. 2023).

Key definitions

Agricultural practice adoption, sometimes referred to as agricultural practice change, occurs when a farmer implements (i.e. 'adopts') a new land management practice or technology (Coggan et al. 2021). The practice is generally something that is the target of an agricultural extension program. Historically, adoption was often treated as a binary concept – adoption versus no adoption. Nevertheless, it is now understood that the process of adoption is dynamic, and that there are different types of adoption that can move through stages of trialling and implementation at different scales, and that can include when a practice is 'given up', or dis-adopted (Coggan et al. 2021; Montes de Oca Munguia et al. 2021).

Behavioural science is the scientific study of mind and behaviour, and explores what shapes our everyday behaviours. Many research disciplines apply behavioural science to explore drivers of behaviour, including psychology, economics, sociology, and social marketing. These disciplines develop and apply diverse theories to explore what influences behaviour. Behavioural science research typically uses the word 'behaviours' rather than practices. Adoption and practice change can be considered analogous to 'behaviour change' as discussed in the broader behavioural sciences literature. Put simply, behaviour change is a catch-all phrase to encompass deliberate efforts to change people's behaviour or practices (Michie et al. 2011), whether it be eating a healthier breakfast or the adoption of an agricultural technology. Importantly, while the target behaviour may vary across circumstances, psychological theories posit that the necessary ingredients for action are universal. We discuss these in the section below.

Necessary ingredients for behaviour change: motivation, capacity and opportunity

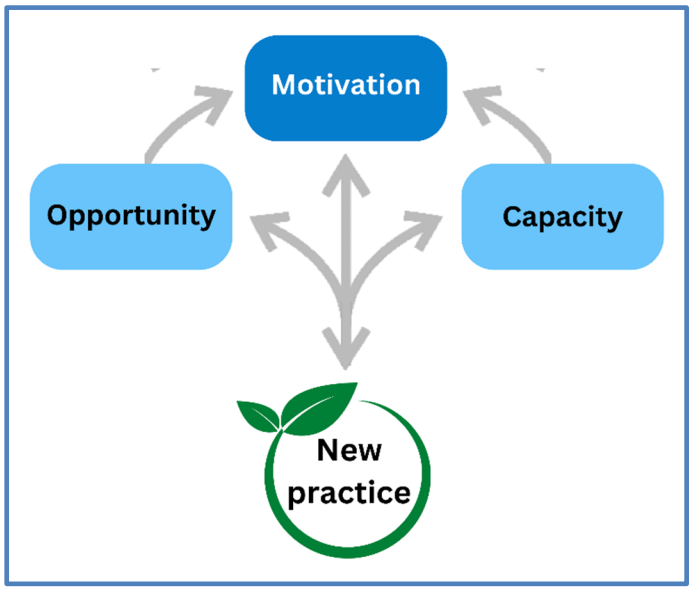
With regards to what factors enable an individual to adopt a new practice, Michie and colleagues (Michie et al. 2011) aimed to identify the most 'basic' elements to simply outline what was required to change behaviour. They identified three key necessary ingredients (Figure 1):

- *Motivation* is defined as 'all the brain processes that energise and direct behaviour (Michie et al. 2011, p. 4). This could include analysis of information to support decision making, but could also include a broader range of mental processes, such as emotions, mental models, cultural identity and habits.
- *Capability* is defined as capacity to adopt the behaviour. It includes both physical and psychological capacity – such as the physical tools or strength needed, the knowledge about the behaviour or practice, as well as having all other things – such as financial capacity or mental skills —that enable adoption.
- *Opportunity* recognises the importance of the external context for behaviour. For example, if extension officers are encouraging adoption of riparian management actions, farmers would need to have access to riparian areas on farm for them to have the opportunity to consider this.

These are not relationships that flow in one direction: while these factors support action, performing a behaviour can also influence motivation, capacity and/or opportunity. For example, trialling a new practice can develop skills and build capacity, seeing the outcomes of the practice can strengthen motivation. While the original model used unidirectional arrows from opportunity and capacity to motivation, it is possible that these relationships are also bi-directional. For example, motivation may encourage landholders to seek out capacity development opportunities.

Extension programs can support these three foundations for adoption in different ways. Extension programs can strengthen capability by providing farmers with skills training, tools and other types of support that enabled adoption of new practices. In some scenarios, extension programs may strengthen opportunity to act by providing access to technologies or services. However, most psychological approaches focus on strengthening motivation. These approaches draw from behavioural theories that have been developed to explain why people do, or do not, adopt new behaviours or practices.

Figure 1. Key ingredients that support adoption of new behaviours and practices



Adapted from Michie et al. 2011.

Psychological theories and constructs

A key element of psychological approaches to behaviour change is identifying what modifiable factors influence the adoption of new behaviours. Identifying factors that enable or constrain adoption of new practices allows programs to strengthen factors that support change, or tackle factors that may create a barrier to change. Rather than capturing all the complex factors that contribute to behaviour, these approaches seek to identify key psychological factors that are readily modifiable, and can be targeted for change.

Through extensive research and experimental enquiry over the past century, highly influential theories or models have been developed that identify key psychological factors that influence behaviour. Many of these theories provide insights that are relevant for extension professionals. In the following sections, we describe these theories and the various psychological factors that support adoption (Figure 2).

Theory of planned behaviour

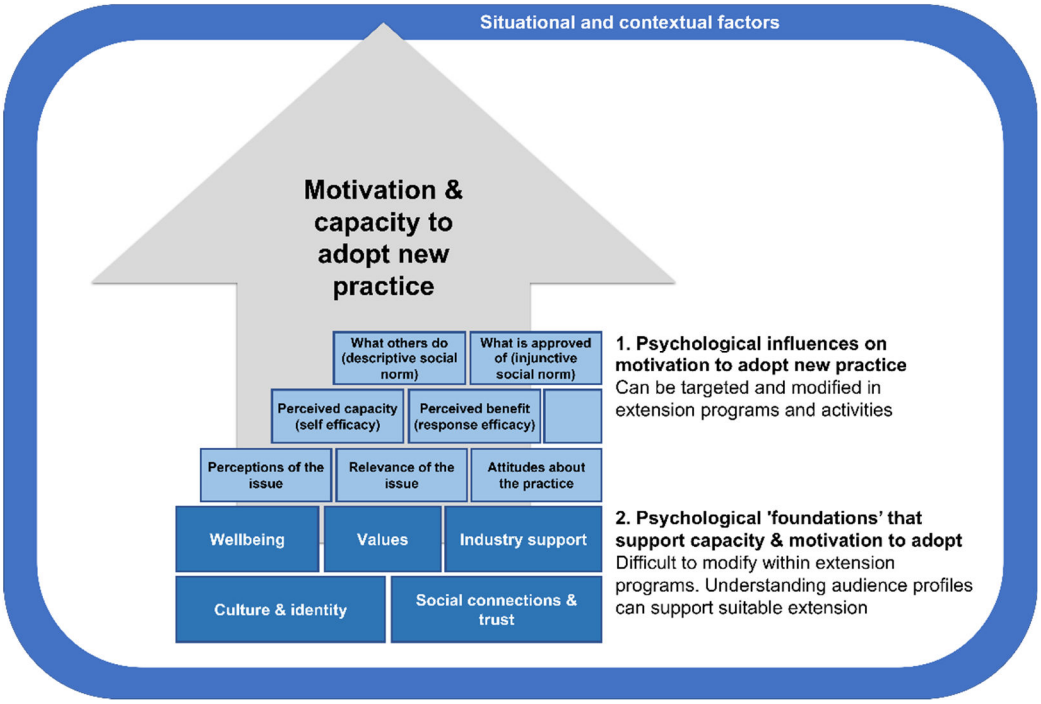
The Theory of Planned Behaviour was one of the first theories to gain prominence to explain why people do and do not adopt certain behaviours (Ajzen 1991). The theory contends that behaviour is driven by an intention to perform a behaviour, which, in turn, is directly influenced by three psychological factors (Alabaster & Hawthorne 1999):

- *Attitudes* about the behaviour or practice, and whether individuals view these practices as positive or negative.
- *Social norms* are whether the practice is perceived to be something that most people would do, or would support.
- *Perceived behavioural control* is the perceived difficulty of adopting the new practice, also referred to as 'self efficacy'.

What this means is that, before someone is willing to change their behaviour, they need to first think it is a good idea (i.e. positive attitude), that it is within their ability to do it and it is relatively easy to do (i.e. high perceived behavioural control), and the people that they care about agree it is a good thing to do (i.e. positive social group norms).

This theory is ubiquitous in behaviour change research and has been successfully applied to understand intentions to engage in agricultural and land management practices (Fielding et al. 2005; Fielding et al. 2008b; Hyland et al. 2018; Simmons et al. 2021; Uebel et al. 2021b). Although this theory is widely used, it is important to recognise it has also been criticised for not taking into account important situational and contextual factors that may be especially important for translating intentions into actual behaviour (Sniehotta et al. 2014). Reinforcing the notion that this theory only partially explains behaviour, many studies that apply it also integrate additional explanatory factors within the research, such as attendance at workshops, social capital and experience in the region (Hasan et al. 2021; Simmons et al. 2021; Uebel et al. 2021b).

Figure 2. Examples of psychological factors that can (1) influence motivation to adopt new behaviours and practices, and (2) can influence both capacity and motivation to adopt new behaviours and practices



Group Social Norms

Building on the Theory of Planned Behaviour, much research shows that group norms have a strong influence on behaviour. Norms are the, often unspoken, rules that set what is considered normal and approved of behaviour within a group (Cialdini & Goldstein 2004). Research shows that people are most strongly influenced by the norms of the groups that are most important to them—the more strongly someone identifies with a group, the more influential norms will be for shaping behaviour (Fielding et al. 2008b; Hobman & Taylor 2018).

In the context of agricultural practices, perceptions that other farmers are adopting the practice (descriptive norm) or approve of the practice (injunctive norm) are associated with greater willingness to adopt the practice (Fielding et al. 2008b). In practice, this means that communicating the positive behaviours of others can support adoption of new practices. Programs that communicate positive social norms have successfully changed behaviour in a wide range of contexts (Allcott 2011; Taylor & Van Grieken 2015; Farrow et al. 2017; Huber et al. 2018; Tang et al. 2021).

When considering very new practices, adoption rates are typically low which makes it difficult to communicate the positive actions of others. In some circumstances, communicating that others are not adopting a behaviour can send a 'negative message' and actually reduce adoption rates (Allcott 2011). In these circumstances, extension professionals can communicate that other farmers are 'interested in' or 'approve of' the new practice, or work with a local champion who can share their experience with the new practice.

Protection Motivation Theory

More recently, practitioners are applying Protection Motivation Theory (Rogers 1975) to unpack ways to promote action that protects an individual or society against a threat (e.g. drought, climate change, extreme weather). The central tenet of the theory is that individuals will take 'protective action' to tackle a threat when they believe a lack of action would pose a threat to themselves and that taking action will mitigate the threat (Rogers 1975). That is, to motivate practice adoption, a person must feel like the threat is relevant to their lives, and will have consequences for them (threat appraisal), that the practice is within their control (self-efficacy, similar to Perceived Behavioural Control discussed above), that the practice will have the desired impact (response efficacy), and that the "costs" associated with the practice do not create a barrier to action. This theory has been successfully applied to past research on health behaviours, flood protection pro-environmental behaviours and agricultural practices (Floyd et al. 2000;

Bockarjova & Steg 2014; Gebrehiwot & van der Veen 2015; Keshavarz & Karami 2016; Bagagnan et al. 2019; Kothe et al. 2019; Jang & Lee 2022).

For extension professionals, Protection Motivation Theory highlights the importance of strengthening self-efficacy and response efficacy to support action and focusing on issues that are relevant to farmers. Self-efficacy can be strengthened by making sure new practices are as simple as possible and emphasising past successes and achievements of individual farmers. Providing information and experiences about the positive impacts of practice adoption can help to strengthen response efficacy.

Putting psychological factors into practice – case examples

The theories discussed above demonstrate that there are three main mechanisms by which you can increase a landholder's motivation to change their behaviour: strengthen confidence (i.e. self-efficacy), strengthen a sense that the actions will be useful (i.e. response efficacy) and communicate positive group social norms. Examples of these mechanisms that have been applied in previous extension programs and projects are highlighted below.

Strengthening confidence

In cane farming regions of Queensland, a large-scale behaviour change program was implemented to accelerate adoption of a best management practices (BMP) for sugarcane growers through targeting (among other factors) self-efficacy (Pickering et al. 2020). As part of this strategy, they wanted to improve the farmers confidence by highlighting all the positive practice changes made in the past and to make a commitment to further changes through a "Cane Changer Commitment". There is evidence to suggest that this strategy contributed to an increase in adoption of the BMP throughout active project areas (RARE 2020). Another way to strengthen self-efficacy is through the provision of decision-making tools. Providing Haitian farmers with tools to manage climate risks led to an increase in farmers' self-efficacy, which in turn, led to a 63% increase in the adoption of new practices (Staub & Clarkson 2021).

Strengthening perceptions adoption will generate benefits

In some cases, individual landholders may question whether a single farm can make a meaningful difference to a larger environmental issue. This type of low response efficacy has presented a challenge for programs and projects that are targeting improvements to water quality in Queensland to support the Great Barrier Reef. Providing general information about the benefits of practices may be insufficient to alleviate landholder concerns. When issues are contested and there is a low trust in science, such approaches may even contribute to reactance in landholders. To address this, a number of projects have developed novel approaches to allow farmers to better understand the specific impacts of practices on water quality, using technology to 'put the data in the farmers own hands'. In one example, an Australian Government funded project called Project 25 installed water quality sensors in the Russell-Mulgrave catchment in north Queensland (Davis et al. 2021). This allowed sugarcane growers to undertake their own water quality monitoring in real time via a smart phone app (NESP Tropical Water Quality Hub, 2023; Davis et al. 2021). This project led to many of the growers changing their behaviour as well as promoting the results of the project to other non-participating growers. Similar projects have been run in Janes Creek and the Sandy Creek Catchment in Mackay, Queensland (NESP Tropical Water Quality Hub, 2023; Queensland Government, 2022; Reef Catchments, 2022).

Communicating positive social norms

In cane farming regions in Queensland, a thesis project explored the effect on adoption of distributing an online video via farmers social networks. The video clips showcased local farmers undertaking the target practices and conveying positive personal accounts of their experiences (i.e. depicting a positive descriptive social norm). This experimental research demonstrated that the farmers who watched the videos reported more positive social norms and led to a 32% increase in the adoption rate (Thomas 2011).

As another example, a social norm intervention was tested with wine growers in southern France to promote more sustainable pesticide practices. A social norm intervention is an approach that aims to influence behaviour by providing information about a prevailing social norm within a specific community or group. In this instance, while a financial incentive was provided, the program also provided growers with information about how many other wine growers were also signing up for the bonus—this communication of a positive descriptive social norm ultimately lead to increased participation in the program (Kuhfuss et al. 2015).

Positive social norms can also be strengthened through adoption or policy 'champions'. To illustrate, an innovative fertiliser management program that targeted sugarcane farmers in north

Queensland, worked collaboratively with a local grower as a spokesperson for the program, building upon his networks in the community (Arklay et al. 2018). As stated by (Arklay et al. 2018, p. 112), 'despite the closed community of growers who historically had always farmed in a particular way, he was able to sell the message and gain their support'.

Going deeper – foundations for action and change

As discussed in the previous section, psychological theories have identified several factors that can have a direct influence on uptake of behaviours and practices—many of these can be targeted by extension programs as part of their change strategy. However, some psychological influences on behaviours and adoption reflect more distal influences on behaviour, and may be more difficult for extension programs to assess or target for change (Dessart et al., 2019). We refer to these as 'foundational' factors. Here, we consider a range of these factors and explore their potential influence on adoption.

Values and beliefs

It is widely accepted that we are motivated to ensure that how we behave aligns with our values, beliefs and worldviews. There are many theoretical perspectives that describe the relationship between values and behaviour. One of the most common frameworks is the Values Beliefs Norms model of behaviour (Stern 2000), which posits that behaviour is strongly guided by moral norms and values. For example, some landholders might be motivated to adopt new agricultural practices because they are concerned about impacts on the natural environment, sometimes referred to as 'ecocentric values' (Price & Leviston 2014). However, there are many other ways to conceptualise values and how they might influence practices (Simmons et al. 2020). For example, some farmers may be focused on profit maximising, which means they will need to see how a new practice benefits the 'bottom line' before considering adoption. Whereas some farmers may be focused on other dimensions, such as lifestyle values or avoiding risk (Science for Environment Policy 2017; Montes de Oca Munguia & Llewellyn 2020).

Values can change over a lifetime, but are typically considered 'stable', and generally not modifiable within the shorter time frame of many extension programs or behaviour change initiatives. Understanding values of farming groups can help extension professionals in a range of ways. New practices typically have a range of advantages and disadvantages. Understanding the values of the farmer allows extension professionals to focus on advantages of the practice that most align with farmer values. This has been referred to as "jui jitsu persuasion", where it is more effective to 'work with' existing values than to try and change them (Hornsey & Fielding 2017).

Conversely, if an extension program has not been effective, one factor to consider is whether the program aligned with the values of the farming audiences. If an extension program has focused on emphasising environmental benefits, but the audience values more strongly represent risk avoiders or are a more profit-driven, then the program material may be not effectively received.

Another way that values and worldviews can influence success of extension programs relates to their potential influence on how people process information. Two common cognitive biases that are underpinned by our values are attentional bias and confirmation bias:

- *Attention bias* is the tendency to notice certain types of information over others. People will notice information that aligns with their values and beliefs and will—often subconsciously—not detect information that does not align (Meis-Harris et al. 2021).
- *Confirmation bias* occurs when people favour and interpret information in ways that align with existing beliefs. That is, people have a tendency to put greater weight on evidence that confirms their beliefs, and under-value evidence that could disprove it (Nickerson 1998).

When extension professionals provide farmers and landholders with information—via written documents, verbal discussions, and hands-on experiences—farmers are more likely to notice and remember information that aligns with their existing values and beliefs. This can create challenges for extension professionals. Understanding the values and beliefs of farmers can help extension professionals acknowledge the farmer values, and tailor both formal and informal interactions towards these.

Culture and identity

It is well established that farming practices make an important contribution to cultural identity, providing a means for community values, knowledge, traditions, practices to be established, expressed and passed on (Brookfield et al. 2005; Schultz 2015; Daliri et al. 2016; Maxwell et al. 2018). Cultural identity influences actions because individuals are motivated to engage in practices that express their identity, which then validates and strengthens their identity (Fielding et al. 2008a; Wang et al. 2021). This means that some cultural identities can act as a barrier to

adoption. A specific element of agriculture that may contribute to cultural identity relates to its role producing food and tackling food security. Food production has important cultural components (Herrington & Mix 2021). Research shows that identifying as a good food provider may make farmers reluctant to consider practices that are perceived to risk yield (Simmons et al. 2020). Moreover, practices that support cultural identity often continue—not because of profits or production—but because of individuals' need to maintain habits and cultural traditions (Nahuelhual et al. 2020).

Wellbeing and 'mental bandwidth'

It has been suggested that people have a 'finite pool of worry' (Weber 2006), and that stressors associated with daily life may constrain engagement with new information (Dean et al. 2018). Aligned with this research Shah et al. (2012) show that experiencing financial difficulty can influence how people make decisions. For extension professionals, what this means is that farmers who are experiencing high levels of stress may have difficulty engaging with information or programs relating to new practices—i.e. they may not have sufficient 'mental bandwidth' for change (Mayfield et al. 2023). The types of stressors or events that may influence mental bandwidth are diverse: they could include farming related stressors such as financial difficulties, dealing with droughts or floods, changing market opportunities or navigating succession plans. Personal stressors can also have an influence on mental bandwidth for dealing with new farming practices, such as relationship problems, family issues, physical health problems and mental health problems.

For extension professionals, navigating these issues may be difficult or beyond the scope of an extension program. However, understanding the capacity farmers to consider new information and practices can help set realistic expectations about what types of change are feasible. It is also an important reminder to make accessing information and considering new practices as accessible and easy as possible.

Social capital

Social capital has been defined as the social connectedness of a community that enables people, organisations and communities to work together collaboratively for mutual benefit (Edwards 2004). Social capital has many different dimensions, including involvement in social groups, strength and breadth of social connections, and having a sense of shared trust and reciprocity with others (Onyx & Bullen 2000; The World Bank 2015; Cofré-Bravo et al. 2019). Further, it is important to recognise that social capital is shaped by a range of factors. At an individual level, social capital may vary with time spent in the area, history of involvement in the community, and vary across gender and family roles. At a societal level, culture, tradition, social structures, and community institutions can also build and shape social capital (Claridge 2020). Research shows that social capital can have a strong influence on many agricultural practices (Simmons et al. 2020; Uebel et al. 2021b) and support for other environmental initiatives (Dean et al. 2016; Hao et al. 2020). Often, farmers and landholders with stronger social connections are more likely to adopt new practices. Social capital can support adoption of new practices through a range of mechanisms. For example, social connections can provide an opportunity or mechanism for:

- actively sharing information about practices
- observing the views and practices of others, and thereby activating positive social norms and increasing familiarity with the new practice
- sharing positive experiences about the benefits of the new practice, and thereby increase visibility of benefits and perceived advantage of practices.

While social capital is typically considered as a resource that supports adoption of new practices, social capital may sometimes have the opposite effect. For example, in scenarios where practices are contested by social groups, stronger social connections among these groups may result in farmers and landholders being less likely to adopt new practices.

The key take-home here is that our social network can influence our actions via diverse pathways. The capacity for an individual farmer to generate social connections with other landholders may vary with many factors – for example, farmers in geographically remote areas or on very large properties may have less opportunity to meet with other landholders on a regular or casual basis. People may also vary in their personal preferences for broad versus narrow social networks. If a farmer with a positive experience of a new practice has a strong social network, encouraging them to share their experience can support others in their journey towards adoption.

Industry norms

It is commonly argued that the support of industry organisations is vital for the success of initiatives that promote new practices. From a psychological perspective, social identity theory

provides insights about why industry support is important. According to social identity theory, the extent to which we accept and act upon information received from others will greatly depend on whether the message has come from an 'in-group' or 'out-group' member (Tajfel & Turner 2004). Through a process called 'self-categorisation' (Turner et al. 1987), similarities between ourselves and others in our in-group are accentuated through positive comparisons, whereas negative comparisons are used to discriminate between in-group members and out-group members (Turner et al. 1987). This process creates an 'us' and 'them' situation, whereby people respond to messages from 'out-group' members (i.e. 'them') with negative biases. There is a great deal of research to show that messages from in-group members are more influential and persuasive than those from out-group members (Abrams et al. 1990; Mullen et al. 1992; Hornsey & Imani 2004). Messages from in-group members are likely to be more influential because in-group sources are trusted more and are perceived to be more credible (Ross et al. 2014).

These findings have important implications for extension professionals. Specifically, how information is received will vary depending on the information sources. Representatives of groups such as governments, scientists may be categorized as an 'out-group', which may limit the effectiveness of their engagement with some farming groups. Whereas messages from industry representatives that are categorised as an 'in-group' will be trusted and accepted. Working with trusted messengers and 'in group members' can be a powerful way to strengthen engagement with diverse audiences.

Discussion

In this review paper, we have presented examples highlighting commonly considered psychological factors that influence adoption and explored how these learnings can be applied within an extension setting. This past research has identified that there are diverse factors that influence adoption, and the key take home messages have been described below.

Harness the power of norms and efficacy

In addition to sharing knowledge and skills, extension can strengthen social norms by sharing positive stories about the practices of other farmers and create opportunities for peer learning. In addition to building skills, it is possible to strengthen efficacy by emphasising skills that farmers have developed, provide a voice for diverse farmers, and share stories of their success (Thomas 2011; Hobman & Taylor 2018; David et al. 2022).

Understand 'where farmers are at' – basic needs come before new practices

Take the time to understand the daily challenges that farmers are experiencing, ensuring that extension activities recognise these challenges and take them into consideration. In some circumstances, making it simpler to engage with extension programs can increase engagement. In other circumstances, recognise and accept that farmers struggling with professional or personal issues may have little time left to engage with extension activities (Weber 2006). Perceptions about what challenges can create a barrier to engagement may vary from person to person—but remember that the perceptions of an individual farmer are the ones that matter the most for their extension engagement.

Spend the time to understand and work with values and culture of each farmer

Pitching information to align with values of the audience—sometimes called 'framing'—can make information more accessible and relevant to audiences (Hornsey & Fielding 2017). Identify what motivates individual farmers and emphasise program components that are relevant for this person. For example, if a farmer is focused on yield and production impacts of new practices, then focus on these details. Alternatively, if a farmer is focused on developing a succession plan and retirement, then emphasise how new practices may support farming transitions. Sharing stories can be more effective than sharing facts alone (Dahlstrom 2014; Morris et al. 2019). If practices targeted for change are ones that contribute to culture and identity—these practices can be hard to shift. Where possible, try to see how new practices can strengthen existing identities and cultural practices.

Maximise and use social networks

Social networks can amplify the impact of extension programs (David et al. 2022). If the target audience for an extension program is well connected, then extension practitioners should be aware that information and experience is likely to be shared among the target group (Dean et al. 2016; Uebel et al. 2021a). If those who have adopted the new practice early have had positive experiences – these can be shared, and may encourage others to also adopt, or be willing to consider adoption. Importantly, if early adopters have a negative experience, then this may also filter through the community. When bringing different farmers together, provide opportunities for

formal and informal interactions, which can help build trust and shared understanding (Stern 2018).

Understand and 'work with' industry norms

When industry groups are very supportive of new practices—and the extension programs that promote these new practices—this can create an additional source of information, expertise, and encouragement that supports adoption (Abrams et al. 1990; Mullen et al. 1992; Hornsey & Imani 2004; David et al. 2022). However, when industry groups are not supportive of new practices—and in some cases may be opposed to some practices—this can create a major barrier to effective extension. Options for individual extension officers may be to identify champions or trusted messengers about new practices that are respected by farmers and industry groups (Arklay et al. 2018; Stern 2018). Some involved in the design of extension programs or established practice targets collaborate with industry and inviting them to participate in co-design processes. Such collaboration may identify target practices or opportunities for change that are more feasible or acceptable to industry groups (Thorburn et al. 2011).

Set realistic goals

While the above research shows that considering psychological factors can support effectiveness of extension programs, it is important to also plan extension programs with realistic targets for what is possible and realistic in the short-to-medium term through to a long-term vision. Much of the research on psychological approaches to behaviour change focus on 'simple behaviours'. However, in behavioural terms, agricultural practices are often 'complex behaviours'. Rather than comprising a single action (e.g. switching off an appliance to reduce energy use), even a simple practice such as changing amounts of fertilizer application involves multiple steps, such as seeking information about fertilizer application requirements, monitoring inputs, changing purchasing practices, assessing impacts on yield, and keeping appropriate records (Montes de Oca Munguia et al. 2021). As such, changing an agricultural practice requires changing a complex series of multiple actions over long periods of time. This complexity means that promoting adoption of agricultural practices typically requires more support and longer time periods. Understanding where farmers are at, and collaborations with industry groups supports change over years, rather than months.

We hope that this paper contributes to an increased understanding of how psychological factors can influence adoption, and supports extension practitioners who work with landholders on their journey to practice change.

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